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PROGRESS REPORT

FOR PERIOD ENDING

30 SEPTEMBER 1954

ON

4 INCH ROCKET

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Work performed during period covered by this report consisted of conducting static tests on rocket motors and nozzles made from various materials, both metallic and non-metallic.

In attempting to find a suitable non-metallic material to be used as a motor tube, a glass fiber reinforced plastic tube was acquired and tested. According to information received from the manufacturer of this material, it possessed great hoop strength and could be manufactured in variable sizes. A special test apparatus was designed and fabricated for testing this tube. A number of inhibited JPN powder grains were burned at various pressures in this tube and it was found that pressures up to 5000 psi could be attained without tube rupture. This pressure is considerably greater than operating pressures expected to be encountered in the 4" rocket. The glass reinforced plastic material showed no particular weakness even after several grains had been burned in the same tube.

In conjunction with the above described tests, a number of materials were tested for possible use as rocket motor nozzles. Among these were catalin, linen filled phenolic, glass fiber reinforced polyester, un-reinforced polyester, steel, brass, and aluminum.

It was proposed that plastic be used wherever possible, but it was not certain whether plastic nozzles would be feasible. The high temperatures and gas velocities encountered in the nozzle are capable of eroding materials such as steel with the result that the nozzle throat is enlarged during the rocket firing. Plastic materials were expected to erode even more. However, it was believed that some plastic materials could be found which would stand up fairly well under such conditions and at least exhibit a regular and uniform rate of erosion. In such a case a progressive burning powder grain could be used to compensate for the enlargement of the nozzle throat.

The grain shape chosen for this purpose is a mono-perforated cylinder with a peripheral inhibitor. During burning, this grain's surface area increases to approximately twice its initial area. When fired in a rocket motor with a steel nozzle such a grain should produce a highly progressive pressure-time curve. A number of motors with brass, aluminum, and steel nozzles of various throat diameters were

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fired to test the grain design and establish the relationship between P, the chamber pressure and K, the ratio of powder surface area to nozzle throat area. The P-K relation for this size motor is somewhat different from the well established P-K relationship for JPN powder in larger motors.

The powder grains performed satisfactorily in these tests. With steel and brass nozzles the expected progressive pressure time curves were obtained. Aluminum nozzles eroded very rapidly and the pressure time curve was regressive in spite of the progressive powder grain surface.

Tests conducted on unfilled polyester, glass fiber reinforced polyester, and linen filled phenolic nozzles showed that each material eroded too rapidly, thereby producing a highly regressive time pressure curve. A plastic material known as catalin, a resin produced from phenol and formaldehyde, exhibited an erosion rate closer to the required rate than any of the other materials tested. The pressure time curve was sometimes progressive and sometimes regressive depending upon the initial throat area. Once the required equilibrium pressure was determined, the size of the nozzle opening could be adjusted to produce this pressure.

Further tests, using glass fiber reinforced plastic motor tubes and catalin nozzles were conducted to determine if multiple motors could be successfully ignited and burned. A special apparatus to accommodate as many as fifteen separate motor tubes were designed and constructed. Four-inch long grains of JPN powder, in groups of 3 and 6, were fired successfully in this apparatus.

PLANS FOR FUTURE WORK:

The task of investigating various materials for possible use in this unit will continue.

Other phases of this program will be carried out as outlined in the monthly progress report for August 1954.

FINANCIAL STATEMENT:

Amount of Contract

Expenditures for September 1954

Total Expenditures to 30 September 1954

Unexpended Balance

50X1

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